



**IN THE UNITED STATES DISTRICT COURT  
FOR THE NORTHERN DISTRICT OF GEORGIA  
ATLANTA DIVISION**

**DONNA CURLING, ET AL.,  
Plaintiffs,**

**v.**

**BRAD RAFFENSPERGER, ET AL.,  
Defendants.**

**Civil Action No. 1:17-CV-2989-AT**

**REBUTTAL REPORT OF ANDREW W. APPEL**

July 30, 2021

1. My name is Andrew W. Appel.
2. My background, qualifications, and professional affiliations are set forth in my Export Report of June 28, 2021.
3. In this report I respond to the Declaration of Dr. Juan Gilbert dated July 16, 2021.
4. In his Paragraph 6 Dr. Gilbert says “I agree that any computer can be hacked ...” and correctly points out that even scanners (optical scan voting machines) and voter registration systems can be hacked. Then he writes that the fact that all such machines can be hacked is “largely irrelevant,” with which I disagree. Dr. Gilbert’s statement is not consistent with accepted cybersecurity principles in the election security field. The significance of the vulnerability of all computer-based voting equipment is that *any part of the voting process that depends on computers must also be checkable and correctable independently of the computers*. For example, voter registration systems can be checkable and correctable in that individual voters can find out, before or on the day they vote, whether they are registered (and at what address, etc.); and so the candidates and the parties can get lists of registered voters; and there are means of correcting the registrations. Checking and correcting optical scanners is not quite as straightforward, because the need for the secret ballot means that individual ballots cannot be linked to

individual voters, but well understood procedures for properly conducted risk-limiting audits (RLAs) can *detect* when hacking (or error) has corrupted the count in an election subject to such an audit, and hand recounts can *correct* the count. In contrast, there is no known way to reliably detect or correct hacks of Ballot-Marking Devices.

5. In paragraph 8 Dr. Gilbert points out that bad ballot designs can lead voters astray in verifying their hand-marked paper ballots (HMPBs) before casting them. This is true; I have written about it myself.<sup>1</sup> But bad ballot designs can be avoided by following well-understood procedures—namely, the 2007 publication of the U.S. Election Assistance Commission, *Effective Designs for the Administration of Federal Elections*, Section 3: Optical scan ballots. There are no such established procedures for Ballot-Marking Devices.

6. In paragraph 9 Dr. Gilbert writes, “Time spent reviewing a ballot however has little to do with whether it was actually verified.” But the study he refers to<sup>2</sup> documented times as short as 0 seconds (about half of voters did not review their ballots at all) and averaging one-fifth of a second per contest (among voters who did review their ballots). At that extreme, the lack of time spent must surely have

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<sup>1</sup> Florida is the Florida of ballot-design mistakes, by Andrew W. Appel, *Freedom-to-Tinker.com*, November 14, 2018. <https://freedom-to-tinker.com/2018/11/14/florida-is-the-florida-of-ballot-design-mistakes/>

<sup>2</sup> R. DeMillo, R. Kadel, and M. Marks. What voters are asked to verify affects ballot verification: A quantitative analysis of voters’ memories of their ballots, November 2018. <https://ssrn.com/abstract=3292208>.

something to do with a lack of verification, and so I do not see how Dr. Gilbert can support such a sweeping statement.

7. In Paragraph 9 Dr. Gilbert writes, “I am unaware of research, and Dr. Appel cites none, that indicates how long is sufficient to recognize an error.” See, for example, the 2007 work by Sarah P. Everett that shows the cognitive difficulty voters have in recognizing such errors.<sup>3</sup>

8. In paragraph 8 Dr. Gilbert writes, “This is particularly so when ballots are printed as they are in Georgia,” by which he suggests that Georgia ballots printed by Georgia’s BMDs are easy to read and to correct. But Georgia’s BMD-printed ballots are, in fact, confusing—difficult to read and understand. I wrote about this in an article published February 1, 2021, in which I cited and discussed a ballot printed in November 2020 by a Dominion ICX in Cherokee County, Georgia.<sup>4</sup>

9. In Figure 1, I show a November 2020 BMD-printed ballot from Oconee County, which is similarly complex. There are 22 contests printed on this ballot;

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<sup>3</sup> S.P. Everett. The Usability of Electronic Voting Machines and How Votes Can Be Changed Without Detection. PhD thesis, Rice University, 2007.


<sup>4</sup> Georgia’s election certification avoided an even worse nightmare that’s just waiting to happen next time, by Andrew W. Appel, *Freedom-to-Tinker.com*, February 1, 2021. <https://freedom-to-tinker.com/2021/02/01/georgias-election-certification-avoided-an-even-worse-nightmare-thats-just-waiting-to-happen-next-time/>

Figure 1. BMD-printed ballot from Georgia's November 2020 Election

**OCONEE COUNTY  
OFFICIAL BALLOT  
GENERAL AND SPECIAL ELECTION  
OF THE STATE OF GEORGIA  
NOVEMBER 3, 2020**

*"I understand that the offer or acceptance of money or any other object of value to vote for any particular candidate, list of candidates, issue, or list of issues included in this election constitutes an act of voter fraud and is a felony under Georgia law." [O.C.G.A. 21-2-284(e), 21-2-285(h) and 21-2-383(a)]*

101-Antioch



For President of the United States (Vote for One) (NP) Vote for Donald J. Trump (I) (Rep)	For State Representative In the General Assembly From 119th District (Vote for One) (NP) Vote for Marcus A. Wiedower (I) (Rep)	For County Commissioner Post 1 (Vote for One) (NP) Vote for Mark H. Thomas (I) (Rep)
For United States Senate (Perdue) (Vote for One) (NP) Vote for David A. Perdue (I) (Rep)	For District Attorney of the Western Judicial Circuit (Vote for One) (NP) Vote for James Chafin	For County Commissioner Post 3 (Vote for One) (NP) Vote for Amrey Harden (Rep)
For United States Senate (Loeffler) - Special (Vote for One) (NP) Vote for Doug Collins (Rep)	For Clerk of Superior Court (Vote for One) (NP) Vote for Angela C. Elder-Johnson (I) (Rep)	For County Commissioner Post 4 (Vote for One) (NP) Vote for Mark T. Saxon (I) (Rep)
For Public Service Commissioner (Vote for One) (NP) Vote for Jason Shaw (I) (Rep)	For Sheriff (Vote for One) (NP) Vote for James A. Hale, Jr. (Rep)	For County Board of Education Chairman Post 1 (Vote for One) (NP) Vote for Tom Odom (I) (Rep)
For Public Service Commissioner (Vote for One) (NP) Vote for Lauren Bubba McDonald, Jr. (I) (Rep)	For Tax Commissioner (Vote for One) (NP) Vote for Jennifer T. Riddle (I) (Rep)	For County Board of Education Post 4 (Vote for One) (NP) Vote for Tim Burgess (I) (Rep)
For U.S. Representative in 117th Congress From the 10th Congressional District of Georgia (Vote for One) (NP) Vote for Jody Hice (I) (Rep)	For Coroner (Vote for One) (NP) Vote for Ed Carson (I) (Rep)	For County Board of Education Post 5 (Vote for One) (NP) Vote for Michael D. Ransom (Rep)
For State Senator From 46th District (Vote for One) (NP) Vote for Bill Cowsert (I) (Rep)	For County Commission Chairman (Vote for One) (NP) Vote for John E. Daniell (I) (Rep)	Constitutional Amendment #1 (NP) Vote for NO
		Constitutional Amendment #2 (NP) Vote for NO

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each contest (and the voter's purported selection) is described in an average of 15

words and abbreviations, in fairly small print; in all there are 407 words on this page. In five seconds it would be difficult for *any* human being to detect whether the vote recorded in every contest is the one they selected on the touch screen; and in five seconds it would be difficult even to notice that this is only side one of a two-sided ballot, and there are more contests (and votes) printed on the other side.

10. A report commissioned by the Georgia Secretary of State, performed by professors at the University of Georgia, measured how much time Georgia voters spent reviewing their BMD-printed ballots in the November 3<sup>rd</sup>, 2020 general election.<sup>5</sup> They found that 91% of voters spent *less than five seconds* reviewing their ballot (and 48% of voters spent *one second or less*). Since there were 24 contests on the Oconee ballot (including side 2), five seconds would be an average of one-fifth of a second per contest.

11. I am not an expert on human visual cognition, but I can understand that this limited time spent by real voters may be roughly consistent with the findings of the University of Michigan study that only 7% of voters noticed an actual error on the ballot when such error was deliberately placed by the Michigan researchers.

12. Dr. Gilbert does not address this or other confusing ballots used in Georgia

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<sup>5</sup> *Georgia Voter Verification Study [Draft Version 1.0]*, by Audrey A. Haynes and M. V. Hood III, School of Public and International Affairs, University of Georgia, January 22, 2021.

elections.

13. In paragraph 10 Dr. Gilbert suggests, implicitly, that there would be “significant improvement in the rates of review and detection when a voter is prompted as Georgia law and regulations require.” But the above-cited study of Georgia voters by Professors Haynes and Hood found: reminding voters to review their ballot increased the proportion of voters who checked their ballot *for at least 2 seconds* only from 48% to 53%. From this evidence I conclude that prompting voters as Georgia law requires does not solve the problem with BMDs.

14. In paragraph 12 Dr. Gilbert analyzes a scenario in which, hypothetically, BMDs were hacked to change just enough votes to alter the outcome of Georgia’s 2020 contest for Presidential Electors. In this scenario, he posits that 832 voters spread over 154 counties would detect that the BMD-printed ballot contained a vote for President different from the one they believed they touched on the screen. Supposing that those voters knew to tell the pollworker, then statewide there would have been 832 ballots “spoiled” and re-marked for that reason. Dr. Gilbert has two things to say about this hypothetical scenario, which I will address separately. But—to be clear—I am not alleging that the Dominion ICX ballot-marking devices *were* hacked in the 2020 election; we must treat this as a hypothetical scenario. I have not had access to any election equipment used in any Georgia election and so

I cannot assess whether any such equipment was hacked.

15. First, he thinks it is “unlikely” that, *if* 800+ voters statewide experienced this problem, that no voter would provide testimony in relation to a claim about it. Whether or not this is the case, Dr. Gilbert avoids engaging with the consequences that I described in my expert report: If some voters did make their claims public, there is no way that election administrators can determine whether this is evidence that many thousands (or even hundreds) of votes have been stolen. I understand Georgia has deployed over 30,000 BMDs across the state for statewide elections like the 2020 Presidential election. 832 spoiled ballots from 832 voters who caught an error on their ballot would amount to only a single spoiled ballot for at least every 36 BMDs across the state on average. In that scenario, most BMDs would have no spoiled ballots from any voter claiming an error on the ballot; and a handful of BMDs would have only one such spoiled ballot.<sup>6</sup> Dr. Gilbert offers no reason—nor is there any—to believe that such a scenario would cause any poll worker, much less state election officials, to suspect a hack of the election system. And even if (counterfactually) election administrators could use this as a means of *detection* of hacking, there is no way they can *correct* the count. Dr. Gilbert does

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<sup>6</sup> and with probability 99.8% there would be not even one BMD with *two or more* instances of a changing a vote and then the voter noticing.



not address this fact at all. This highlights the serious problem of leaving significant security vulnerabilities unremedied with an election system like that used in Georgia: if exploited, which is a substantial risk in today's environment of sophisticated actors attempting to manipulate U.S. elections, the effects of stealing individual voters' votes and even altering election outcomes are likely to go undetected and thus uncorrected; and even if detected, there is no apparent means of reversing those effects short of re-running the entire election in a more secure election system. While a properly-conducted RLA of such an election potentially could detect such a hack, there would be no means of correcting the election outcome or restoring individual voters' votes with Georgia's BMD system.

16. Second, Dr. Gilbert writes, "Even still, it would mean there are 832 spoiled BMD ballots." But I am not aware that Georgia polling places keep reliable records of how many spoiled ballots there are, and for what claimed reasons, or that these records are aggregated statewide for analysis. So there might *be* 832 (or many more) spoiled ballots in Georgia from the 2020 Presidential election, but it is not clear who, if anyone, would know that. Dr. Gilbert does not indicate that he has undertaken any such investigation, including inquiring of the Secretary of State's Office, which engaged him in this case.

17. In paragraph 14 Dr. Gilbert discusses the use of BMDs by voters with

disabilities. Indeed, voters with severe or total vision impairment will have difficulty verifying a BMD-printed ballot.<sup>7</sup> Therefore voters with disabilities who use a BMD are at least as vulnerable to BMD-hacking as any other voters. In my opinion, it would be a reasonable policy to preserve several options for voters with disabilities: voting by mail on a hand-marked paper ballot, perhaps with the assistance of a person they trust to mark the ballot; voting by BMD; and so on. But that is not a reason to needlessly subject voters who *can* mark a paper ballot by hand to the risk of their vote being stolen by computer hacking.

18. In paragraph 14 Dr. Gilbert quotes some misleading statistics. If “approximately 500,516 disabled Georgians voted in 2020,” that does not mean that all 500,516 have disabilities that prevent them from marking a paper ballot by hand; and of those that do, it does not mean that all of them opted to vote in a polling place instead of by mail. It stands to reason that a very small portion of those voters with disabilities could not mark a paper ballot by hand at a polling site or at home with an absentee ballot. Dr. Gilbert does not indicate any effort to determine this number and his implication that this holds for all (or even most) of the 500,516 Georgia voters with disabilities is misleading.

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<sup>7</sup> But it is not impossible for them to do so, especially now that handheld devices are readily available that will read and speak text that is printed on paper.

19. In conclusion, nowhere does Dr. Gilbert address any of these points from my expert report:

- a. that the majority of individual voters are susceptible to having their own individual votes changed by BMDs in ways that they will not detect;
- b. that if some (small or large) fraction of voters does detect the hacking, they have no recourse except to correct their own vote;
- c. that if many voters did report that their votes came out differently on the paper than they recalled indicating on the touchscreen, election officials could not reliably draw conclusions about whether this indicates the BMDs had been hacked;
- d. and that if election administrators *did* come to the conclusion that the BMDs had been hacked enough to change many votes, there is no remedy they could apply to correct the count or restore individual votes.

Executed on this 30th day of July, 2021, in Ithaca, New York.

A handwritten signature in blue ink, appearing to read "Andrew Appel", written over a horizontal line.

Andrew W. Appel